# BGA824N6

## Silicon Germanium Low Noise Amplifier for Global Navigation Satellite Systems (GNSS)

### Features

- Operating frequencies: 1164 - 1615 MHz
- Insertion power gain: 17.0 dB
- Input 1 dB compression point: -6 dBm
- Low noise figure: 0.55 dB
- Low current consumption: 3.8 mA
- Digital on/off switch
- Ultra small TSNP-6-2 and TSNP-6-10 leadless package
- RF output internally matched to 50 Ohm
- Low external component count



**0.7 x 1.1 mm²**
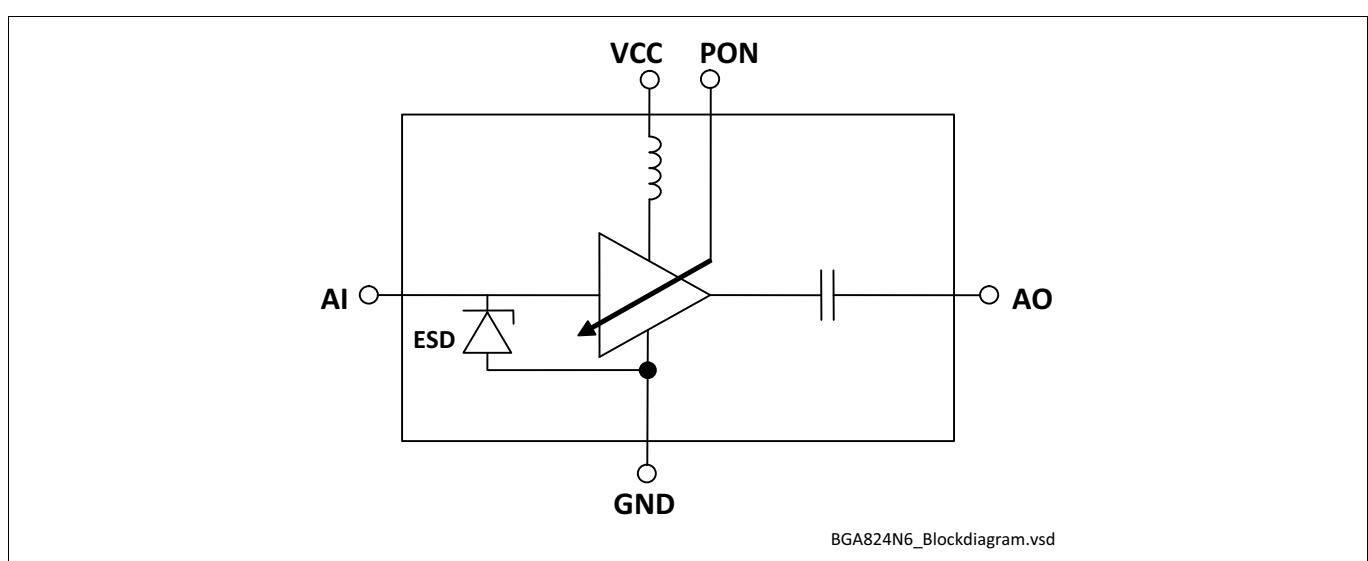
### Application

Ideal for all Global Navigation Satellite Systems (GNSS) like GPS, GLONASS, Beidou, Galileo and others.

### Product Validation

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22

### Block diagram
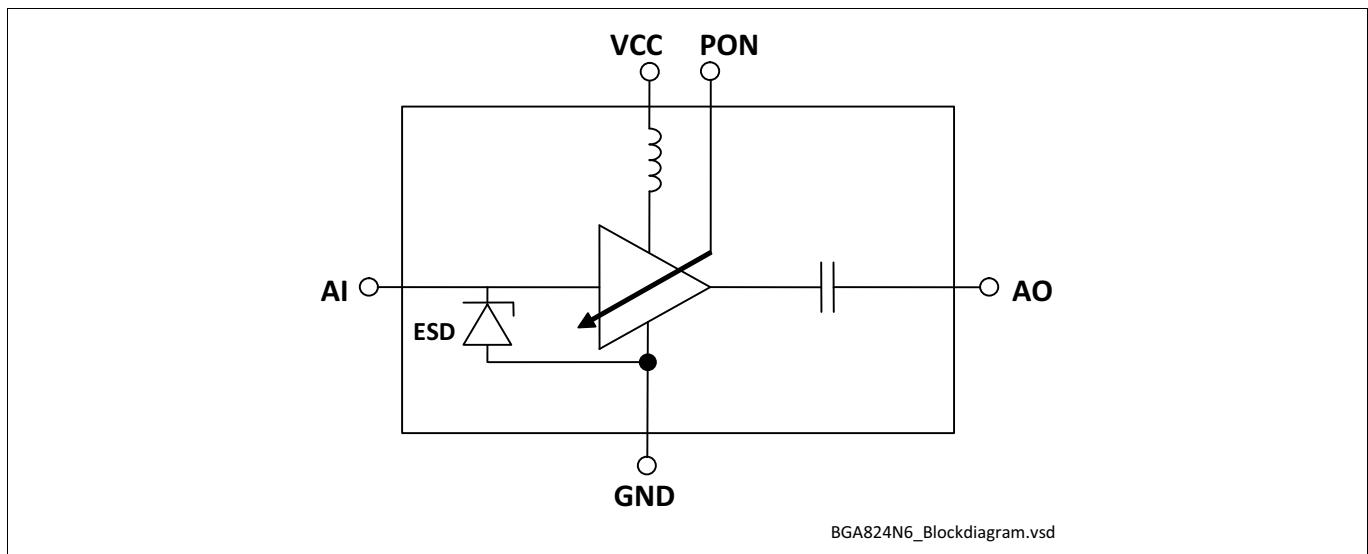


BGA824N6_Blockdiagram.vsd

# Table of Contents

# 1 Features

- Insertion power gain: 17.0 dB
- Out-of-band input 3rd order intercept point: +7 dBm
- Input 1 dB compression point: -6 dBm
- Low noise figure: 0.55 dB
- Low current consumption: 3.8 mA
- Operating frequencies: 1164 - 1615 MHz
- Digital on/off switch
- Supply voltage: 1.5 V to 3.6 V
- Ultra small TSNP-6-2 and TSNP-6-10 leadless package (footprint: 0.7 x 1.1 mm$^2$)
- B7HF Silicon Germanium technology
- RF output internally matched to 50 Ohm
- Low external component count
- 2kV HBM ESD protection (including AI-pin)
- Pb-free (RoHS compliant) package

RoHS



Figure 1    Block Diagram

| Product Name | Marking | Package |
|---|---|---|
| BGA824N6 | F | TSNP-6-2/TSNP-6-10 |

**Features**

**Description**

The BGA824N6 is a front-end low noise amplifier for Global Navigation Satellite Systems (GNSS) from 1164 MHz to 1615 MHz like GPS, GLONASS, Beidou, Galileo and others. The LNA provides 17.0 dB gain and 0.55 dB noise figure at a current consumption of 3.8 mA in the application configuration described in **Chapter 4**. The BGA824N6 is based upon Infineon Technologies' B7HF Silicon Germanium technology. It operates from 1.5 V to 3.6 V supply voltage.

**Pin Definition and Function**

**Table 1      Pin Definition and Function**

| Pin No. | Name | Function |
|---------|------|----------|
| 1 | GND | Ground |
| 2 | VCC | DC supply |
| 3 | AO | LNA output |
| 4 | GND | Ground |
| 5 | AI | LNA input |
| 6 | PON | Power on control |

# 2 Maximum Ratings

**Table 2    Maximum Ratings**

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Voltage at pin VCC | $V_{CC}$ | -0.3 | – | 3.6 | V | [1] |
| Voltage at pin AI | $V_{AI}$ | -0.3 | – | 0.9 | V | – |
| Voltage at pin AO | $V_{AO}$ | -0.3 | – | $V_{CC}$ + 0.3 | V | – |
| Voltage at pin PON | $V_{PON}$ | -0.3 | – | $V_{CC}$ + 0.3 | V | – |
| Voltage at pin GNDRF | $V_{GNDRF}$ | -0.3 | – | 0.3 | V | – |
| Current into pin VCC | $I_{CC}$ | – | – | 23 | mA | – |
| RF input power | $P_{IN}$ | – | – | 25 | dBm | – |
| Total power dissipation, $T_S$ < 148 °C[2] | $P_{tot}$ | – | – | 60 | mW | – |
| Junction temperature | $T_J$ | – | – | 150 | °C | – |
| Ambient temperature range | $T_A$ | -40 | – | 85 | °C | – |
| Storage temperature range | $T_{STG}$ | -55 | – | 150 | °C | – |
| ESD capability all pins | $V_{ESD\_HBM}$ | -2000 | - | +2000 | V | according to JS-001 |

1) All voltages refer to GND-Node unless otherwise noted

2) $T_S$ is measured on the ground lead at the soldering point

*Attention:   Stresses above the max. values listed here may cause permanent damage to the device. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit. Exposure to conditions at or below  absolute maximum rating but above the specified maximum operation conditions may affect device reliability and life time. Functionality of the device might not be given under these conditions.*

Thermal Resistance

**Table 3    Thermal Resistance**

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Junction - soldering point[1] | $R_{thJS}$ | 25 | K/W |

1) For calculation of $R_{thJA}$ please refer to Application Note Thermal Resistance

# 3 Electrical Characteristics

**Table 4    Electrical Characteristics f = 1550 - 1615 MHz, $V_{CC}$ = 1.8V[1]**

$T_A$ = 25 °C, $V_{CC}$ = 1.8 V, $V_{PON,ON}$ = 1.8 V, $V_{PON,OFF}$ = 0 V, $f$ = 1550 - 1615 MHz

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply voltage | $V_{CC}$ | 1.5 | 1.8 | 3.6 | V | – |
| Supply current | $I_{CC}$ | – | 3.8 | 4.8 | mA | ON-mode |
| | | – | 0.2 | 3 | µA | OFF-mode |
| Power On voltage | $V_{PON}$ | 0.8 | – | Vcc | V | ON-mode |
| | | 0 | – | 0.4 | V | OFF-mode |
| Power On current | $I_{PON}$ | – | 5 | 10 | µA | ON-mode |
| | | – | – | 1 | µA | OFF-mode |
| Insertion power gain $f$ = 1575 MHz | $|S_{21}|^2$ | 16.0 | 17.0 | 18.0 | dB | – |
| Noise figure[2] $f$ = 1575 MHz | $NF$ | – | 0.55 | 1.1 | dB | – |
| Input return loss[3] $f$ = 1575 MHz | $RL_{IN}$ | 10 | 14 | – | dB | – |
| Output return loss[3] $f$ = 1575 MHz | $RL_{OUT}$ | 10 | 17 | – | dB | – |
| Reverse isolation[3] $f$ = 1575 MHz | $1/|S_{12}|^2$ | 19 | 23 | – | dB | – |
| Power gain settling time[4][5] | $t_S$ | – | 5 | 8 | µs | OFF- to ON-mode |
| | | – | 5 | 8 | µs | ON- to OFF-mode |
| | | – | 1.2 | 3 | µs | OFF- to ON-mode[6] |
| | | – | 0.9 | 3 | µs | ON- to OFF-mode[6] |
| Inband input 1dB-compression point[3] $f$ = 1575 MHz | $IP_{1dB}$ | -13 | -9 | – | dBm | – |
| Inband input 3rd-order intercept point[3][7] | $IIP_3$ | -3 | +2 | – | dBm | $f_1$ = 1575 MHz $f_2$ = $f_1$ +/- 1 MHz |
| Out-of-band input 3rd-order intercept point[5][8] | $IIP_{3OOB}$ | +2 | +7 | – | dBm | $f_1$ = 1712.7 MHz $f_2$ = 1850 MHz |
| Stability[5] | $k$ | > 1 | – | – | | f = 20 MHz … 10 GHz |

1)  Based on the application described in Figure 2 in **Chapter 4**
2)  PCB losses are subtracted
3)  Verification based on AQL; not 100% tested in production
4)  To be within 1 dB of the final gain OFF- to ON-mode; to be within 3 dB of the final gain ON- to OFF-mode
5)  Guaranteed by device design; not tested in production
6)  120 pF DC block capacitor at RF input
7)  Input power = -30 dBm for each tone
8)  Input power = -20 dBm for each tone

**Electrical Characteristics**

### Table 5 Electrical Characteristics f = 1550 - 1615 MHz, V_CC = 2.8V[1]

$T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $V_{PON,ON}$ = 2.8 V, $V_{PON,OFF}$ = 0 V, $f$ = 1550 - 1615 MHz

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply voltage | $V_{CC}$ | 1.5 | 2.8 | 3.6 | V | – |
| Supply current | $I_{CC}$ | – | 3.9 | 4.9 | mA | ON-mode |
| | | – | 0.2 | 3 | µA | OFF-mode |
| Power On voltage | $V_{PON}$ | 0.8 | – | Vcc | V | ON-mode |
| | | 0 | – | 0.4 | V | OFF-mode |
| Power On current | $I_{PON}$ | – | 10 | 15 | µA | ON-mode |
| | | – | – | 1 | µA | OFF-mode |
| Insertion power gain $f$ = 1575 MHz | $\lvert S_{21}\rvert^2$ | 16.1 | 17.1 | 18.1 | dB | – |
| Noise figure[2] $f$ = 1575 MHz | $NF$ | – | 0.55 | 1.1 | dB | – |
| Input return loss[3] $f$ = 1575 MHz | $RL_{IN}$ | 10 | 15 | – | dB | – |
| Output return loss[3] $f$ = 1575 MHz | $RL_{OUT}$ | 10 | 18 | – | dB | – |
| Reverse isolation[3] $f$ = 1575 MHz | $1/\lvert S_{12}\rvert^2$ | 19 | 23 | – | dB | – |
| Power gain settling time[4][5] | $t_S$ | – | 5 | 8 | µs | OFF- to ON-mode |
| | | – | 5 | 8 | µs | ON- to OFF-mode |
| | | – | 1.2 | 3 | µs | OFF- to ON-mode[6] |
| | | – | 0.9 | 3 | µs | ON- to OFF-mode[6] |
| Inband input 1dB-compression point[3] $f$ = 1575 MHz | $IP_{1dB}$ | -10 | -6 | – | dBm | – |
| Inband input 3$^{rd}$-order intercept point[3][7] | $IIP_3$ | -2 | +3 | – | dBm | $f_1$ = 1575 MHz $f_2$ = $f_1$ +/- 1 MHz |
| Out-of-band input 3$^{rd}$-order intercept point[5][8] | $IIP_{3OOB}$ | +2 | +7 | – | dBm | $f_1$ = 1712.7 MHz $f_2$ = 1850 MHz |
| Stability[5] | $k$ | > 1 | – | – | | f = 20 MHz … 10 GHz |

1) Based on the application described in Figure 2 in **Chapter 4**
2) PCB losses are subtracted
3) Verification based on AQL; not 100% tested in production
4) To be within 1 dB of the final gain OFF- to ON-mode; to be within 3 dB of the final gain ON- to OFF-mode
5) Guaranteed by device design; not tested in production
6) 120 pF DC block capacitor at RF input
7) Input power = -30 dBm for each tone
8) Input power = -20 dBm for each tone

**Electrical Characteristics**

**Table 6    Electrical Characteristics f = 1164 - 1300 MHz, V$_{CC}$ = 1.8V[1]**

$T_A$ = 25 °C, $V_{CC}$ = 1.8 V, $V_{PON,ON}$ = 1.8 V, $V_{PON,OFF}$ = 0 V, $f$ = 1164 - 1300 MHz

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply voltage | $V_{CC}$ | 1.5 | 1.8 | 3.6 | V | – |
| Supply current | $I_{CC}$ | – | 3.8 | 4.8 | mA | ON-mode |
| | | – | 0.2 | 3 | µA | OFF-mode |
| Power On voltage | $V_{PON}$ | 0.8 | – | Vcc | V | ON-mode |
| | | 0 | – | 0.4 | V | OFF-mode |
| Power On current | $I_{PON}$ | – | 5 | 10 | µA | ON-mode |
| | | – | – | 1 | µA | OFF-mode |
| Insertion power gain $f$ = 1214 MHz | $\|S_{21}\|^2$ | 16.4 | 17.9 | 19.4 | dB | – |
| Noise figure[2] $f$ = 1214 MHz | NF | – | 0.70 | 1.25 | dB | – |
| Input return loss[3] $f$ = 1214 MHz | $RL_{IN}$ | 10 | 15 | – | dB | – |
| Output return loss[3] $f$ = 1214 MHz | $RL_{OUT}$ | 10 | 18 | – | dB | – |
| Reverse isolation[3] $f$ = 1214 MHz | $1/\|S_{12}\|^2$ | 19 | 25 | – | dB | – |
| Power gain settling time[4][5] | $t_S$ | – | 5 | 8 | µs | OFF- to ON-mode |
| | | – | 5 | 8 | µs | ON- to OFF-mode |
| | | – | 1.2 | 3 | µs | OFF- to ON-mode[6] |
| | | – | 0.9 | 3 | µs | ON- to OFF-mode[6] |
| Inband input 1dB-compression point[3] $f$ = 1214 MHz | $IP_{1dB}$ | -16 | -12 | – | dBm | – |
| Inband input 3$^{rd}$-order intercept point[3][7] | $IIP_3$ | -11 | -6 | – | dBm | $f_1$ = 1214 MHz $f_2 = f_1$ +/- 1 MHz |
| Out-of-band input 3$^{rd}$-order intercept point[5][8] | $IIP_{3OOB}$ | -3 | +1.3 | | dBm | $f_1$ = 1850 MHz $f_2$ = 2500 MHz |
| Stability[5] | k | > 1 | – | – | | f = 20 MHz … 10 GHz |

1)   Based on the application described in Figure 3 in **Chapter 4**
2)   PCB losses are subtracted
3)   Verification based on AQL; not 100% tested in production
4)   To be within 1 dB of the final gain OFF- to ON-mode; to be within 3 dB of the final gain ON- to OFF-mode
5)   Guaranteed by device design; not tested in production
6)   120 pF DC block capacitor at RF input
7)   Input power = -30 dBm for each tone
8)   Input power = -25 dBm for each tone

**Electrical Characteristics**

## Table 7 Electrical Characteristics f = 1164 - 1300 MHz, V$_{CC}$ = 2.8V[1]

$T_A$ = 25 °C, $V_{CC}$ = 2.8 V, $V_{PON,ON}$ = 2.8 V, $V_{PON,OFF}$ = 0 V, $f$ = 1164 - 1300 MHz

| Parameter | Symbol | Values | | | Unit | Note or Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply voltage | $V_{CC}$ | 1.5 | 2.8 | 3.6 | V | – |
| Supply current | $I_{CC}$ | – | 3.9 | 4.8 | mA | ON-mode |
| | | – | 0.2 | 3 | µA | OFF-mode |
| Power On voltage | $V_{PON}$ | 0.8 | – | Vcc | V | ON-mode |
| | | 0 | – | 0.4 | V | OFF-mode |
| Power On current | $I_{PON}$ | – | 10 | 15 | µA | ON-mode |
| | | – | – | 1 | µA | OFF-mode |
| Insertion power gain $f$ = 1214 MHz | $\lvert S_{21}\rvert^2$ | 16.5 | 18.0 | 19.5 | dB | – |
| Noise figure[2] $f$ = 1214 MHz | $NF$ | – | 0.70 | 1.25 | dB | – |
| Input return loss[3] $f$ = 1214 MHz | $RL_{IN}$ | 10 | 16 | – | dB | – |
| Output return loss[3] $f$ = 1214 MHz | $RL_{OUT}$ | 10 | 18 | – | dB | – |
| Reverse isolation[3] $f$ = 1214 MHz | $1/\lvert S_{12}\rvert^2$ | 19 | 26 | – | dB | – |
| Power gain settling time[4][5] | $t_S$ | – | 5 | 8 | µs | OFF- to ON-mode |
| | | – | 5 | 8 | µs | ON- to OFF-mode |
| | | – | 1.2 | 3 | µs | OFF- to ON-mode[6] |
| | | – | 0.9 | 3 | µs | ON- to OFF-mode[6] |
| Inband input 1dB-compression point[3] $f$ = 1214 MHz | $IP_{1dB}$ | -13 | -9 | – | dBm | – |
| Inband input 3$^{rd}$-order intercept point[3][7] | $IIP_3$ | -10 | -5 | – | dBm | $f_1$ = 1214 MHz $f_2$ = $f_1$ +/- 1 MHz |
| Out-of-band input 3$^{rd}$-order intercept point[5][8] | $IIP_{3OOB}$ | -3 | +1.3 | | dBm | $f_1$ = 1850 MHz $f_2$ = 2500 MHz |
| Stability[5] | $k$ | > 1 | – | – | | f = 20 MHz … 10 GHz |

1) Based on the application described in Figure 3 in **Chapter 4**
2) PCB losses are subtracted
3) Verification based on AQL; not 100% tested in production
4) To be within 1 dB of the final gain OFF- to ON-mode; to be within 3 dB of the final gain ON- to OFF-mode
5) Guaranteed by device design; not tested in production
6) 120 pF DC block capacitor at RF input
7) Input power = -30 dBm for each tone
8) Input power = -25 dBm for each tone

# 4 Application Information

**Application Board Configuration f = 1550 - 1615 MHz**
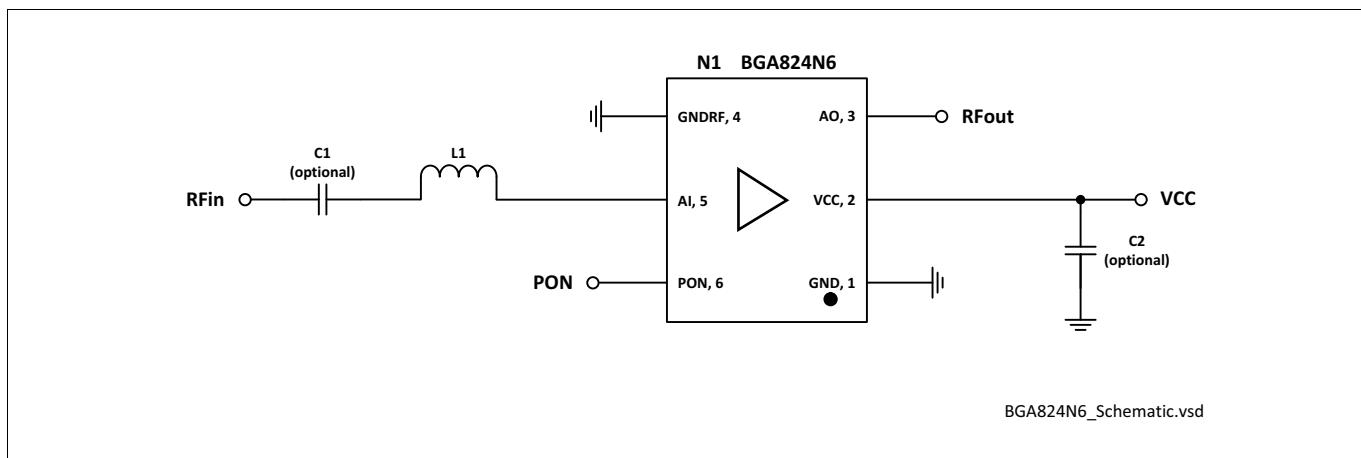


**Figure 2      Application Schematic BGA824N6 f = 1550 - 1615 MHz**

**Table 8      Bill of Materials**

| Name | Value | Package | Manufacturer | Function |
|------|-------|---------|--------------|----------|
| C1 (optional) | 1nF | 0402 | Various | DC block[1] |
| C2 (optional) | ≥ 10nF[2] | 0402 | Various | RF bypass [3] |
| L1 | 6.8nH | 0402 | Murata LQW type | Input matching |
| N1 | BGA824N6 | TSNP-6-2 and TSNP-6-10 | Infineon | SiGe LNA |

1)  DC block might be realized with pre-filter in GNSS application

2)  For data sheet characteristics 1µF used

3)  RF bypass recommended to mitigate power supply noise

A list of all application notes is available at **http://www.infineon.com/gpslna.appnotes**

## Application Information

### Application Board Configuration f = 1164 - 1300 MHz
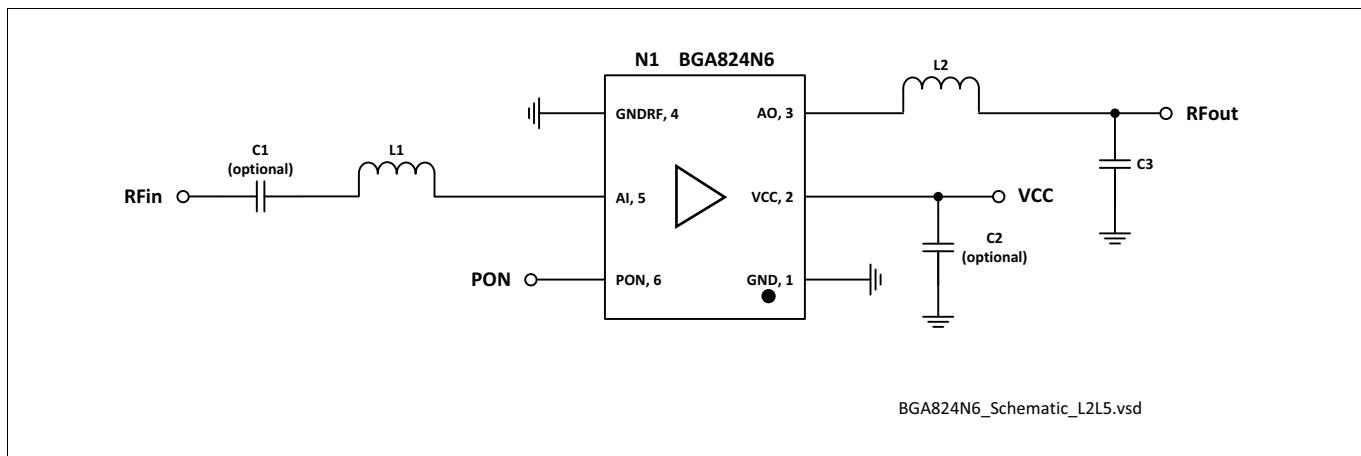


**Figure 3    Application Schematic BGA824N6 f = 1164 - 1300 MHz**

**Table 9    Bill of Materials**
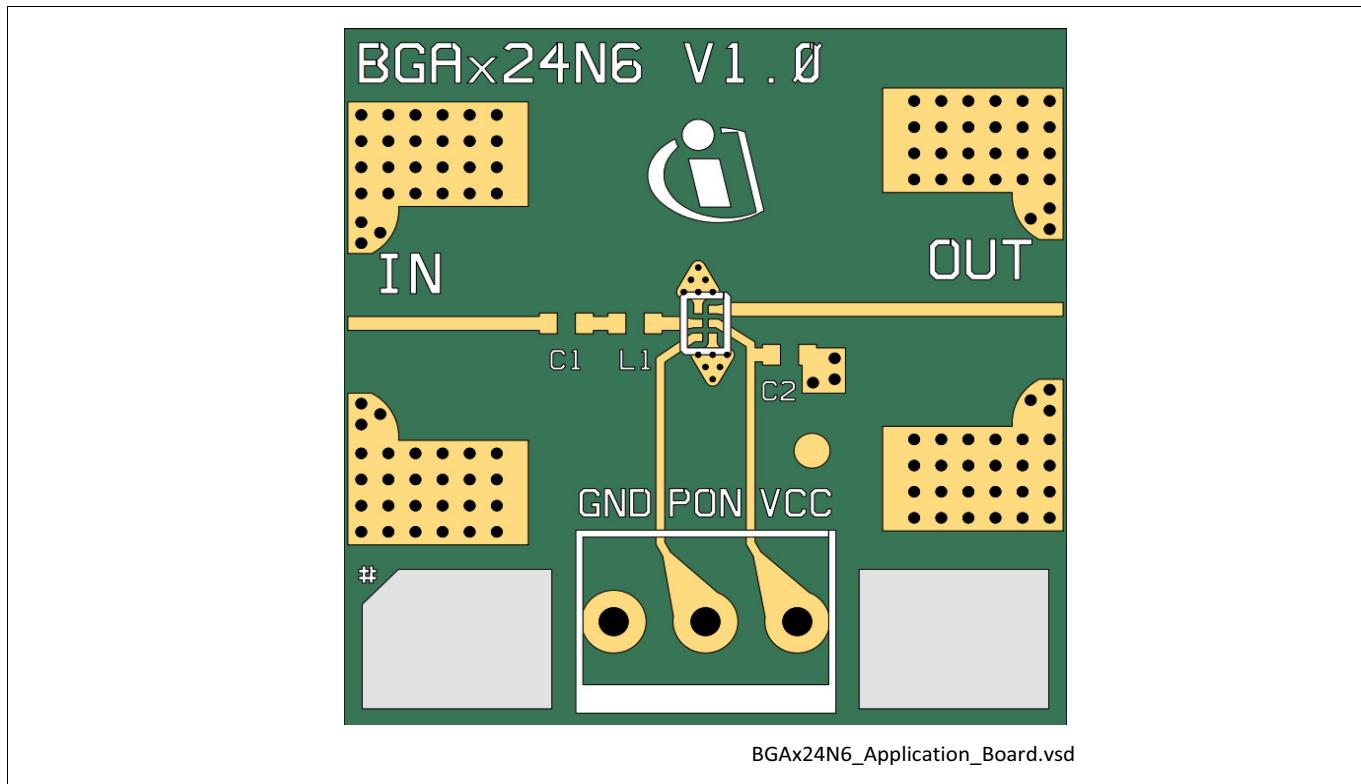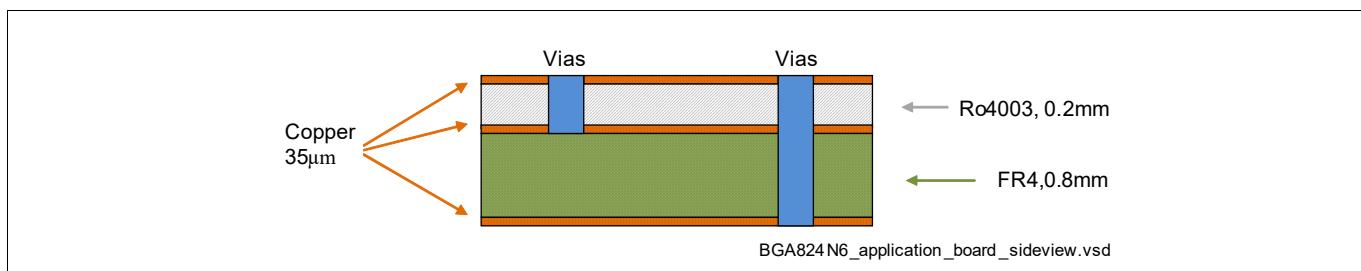
| Name | Value | Package | Manufacturer | Function |
|------|-------|---------|--------------|----------|
| C1 (optional) | 1nF | 0402 | Various | DC block[1] |
| C2 (optional) | ≥ 10nF[2] | 0402 | Various | RF bypass [3] |
| C3 | 3.9pF | 0402 | Various | Output matching |
| L1 | 12nH | 0402 | Murata LQW type | Input matching |
| L2 | 3.9nH | 0402 | Murata LQW type | Output matching |
| N1 | BGA824N6 | TSNP-6-2 and TSNP-6-10 | Infineon | SiGe LNA |

1)   DC block might be realized with pre-filter in GNSS application

2)   For data sheet characteristics 1µF used

3)   RF bypass recommended to mitigate power supply noise

A list of all application notes is available at **http://www.infineon.com/gpslna.appnotes**

**Application Information**



**Figure 4**     **Drawing of Application Board**



**Figure 5**     **Application Board Cross-Section**

# 5 Package Information
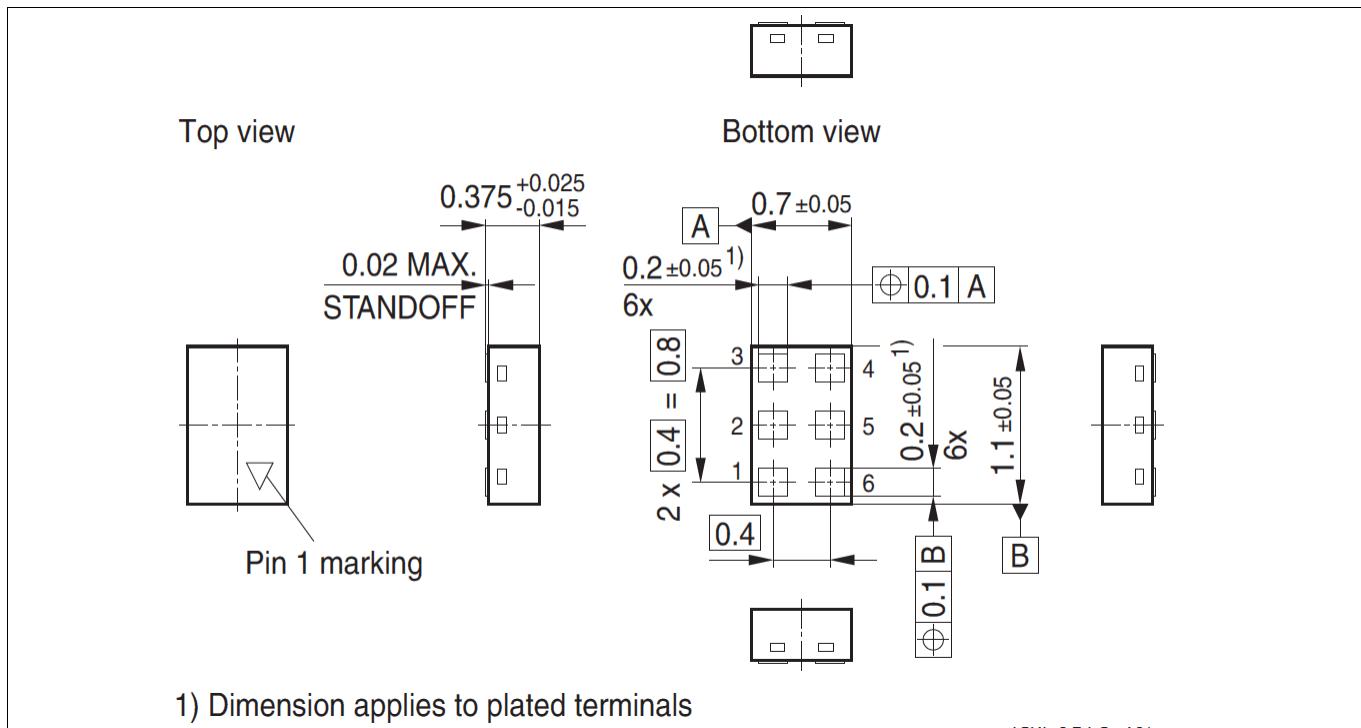


**Figure 6** **TSNP-6-2 Package Outline** (top, side and bottom views)
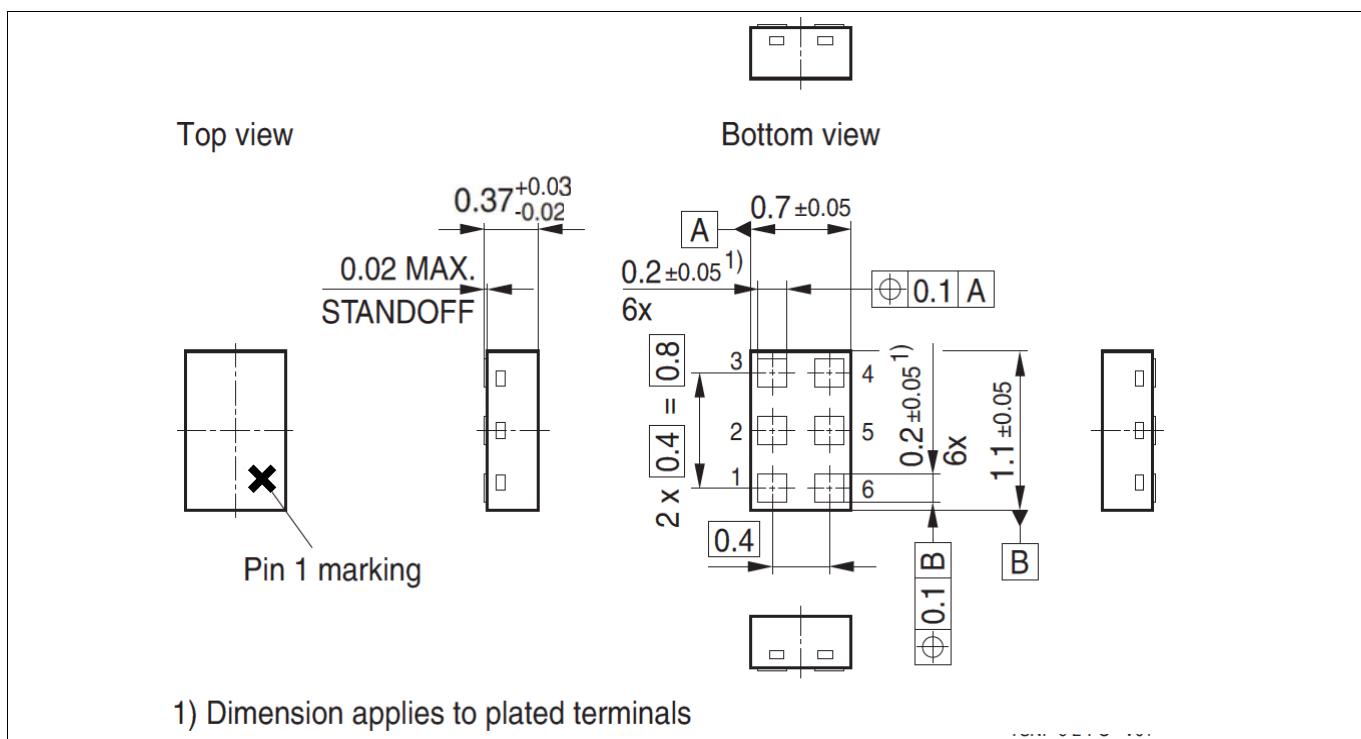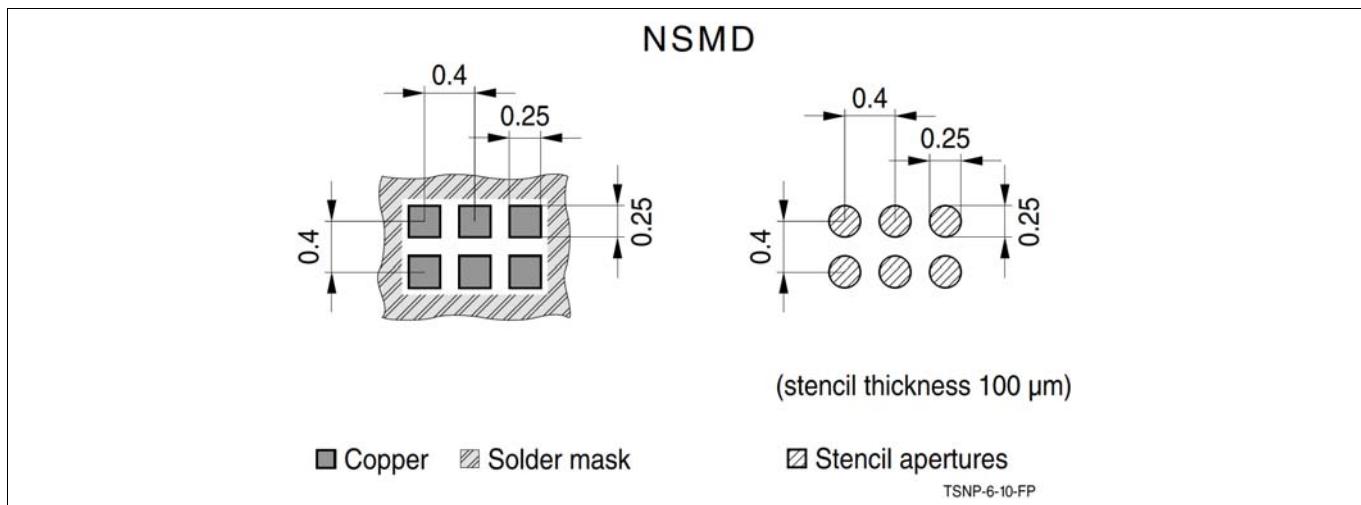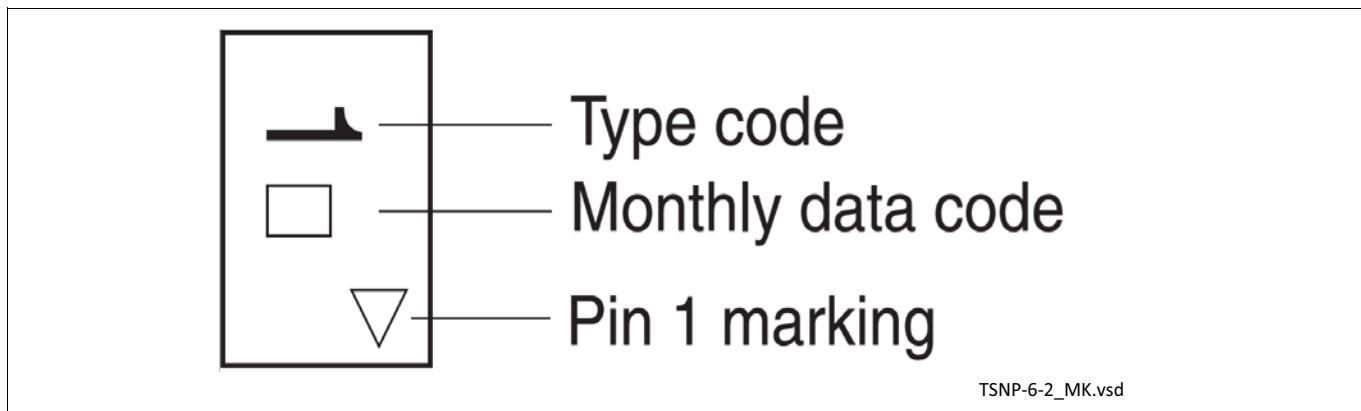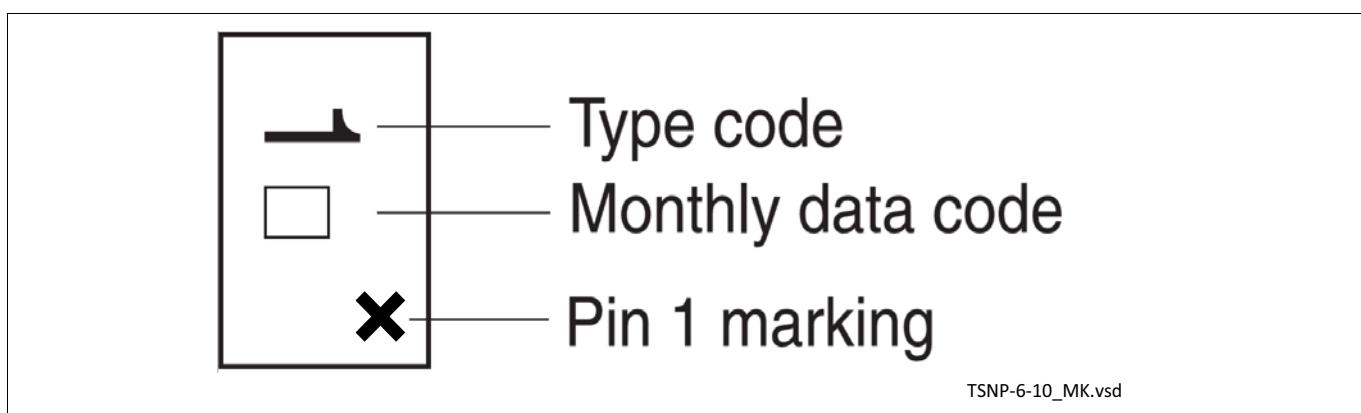


**Figure 7** **TSNP-6-10 Package Outline** (top, side and bottom views)

**Package Information**



**Figure 8     Footprint Recommendation TSNP-6-2 and TSNP-6-10**



**Figure 9     Marking Layout TSNP-6-2** (top view)



**Figure 10    Marking Layout TSNP-6-10** (top view)

**Package Information**

| Month | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|-------|------|------|------|------|------|------|------|------|------|------|------|------|
| 01 | a | p | A | P | a | p | A | P | a | p | A | P |
| 02 | b | q | B | Q | b | q | B | Q | b | q | B | Q |
| 03 | c | r | C | R | c | r | C | R | c | r | C | R |
| 04 | d | s | D | S | d | s | D | S | d | s | D | S |
| 05 | e | t | E | T | e | t | E | T | e | t | E | T |
| 06 | f | u | F | U | f | u | F | U | f | u | F | U |
| 07 | g | v | G | V | g | v | G | V | g | v | G | V |
| 08 | h | x | H | X | h | x | H | X | h | x | H | X |
| 09 | j | y | J | Y | j | y | J | Y | j | y | J | Y |
| 10 | k | z | K | Z | k | z | K | Z | k | z | K | Z |
| 11 | l | 2 | L | 4 | l | 2 | L | 4 | l | 2 | L | 4 |
| 12 | n | 3 | N | 5 | n | 3 | N | 5 | n | 3 | N | 5 |

**Figure 11    Date Code Marking TSNP-6-2 and TSNP-6-10**
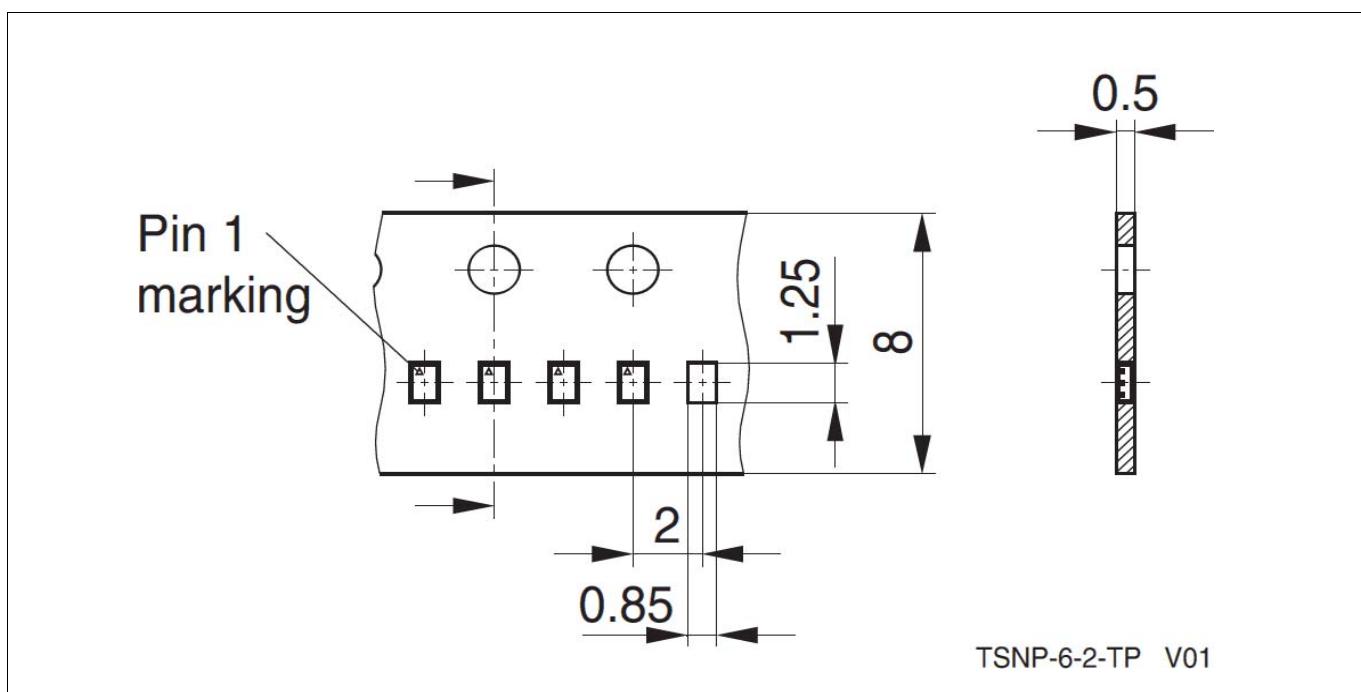


**Figure 12    Tape & Reel Dimensions TSNP-6-2 (reel diameter 180 mm, pieces/reel 15000)**

**Package Information**
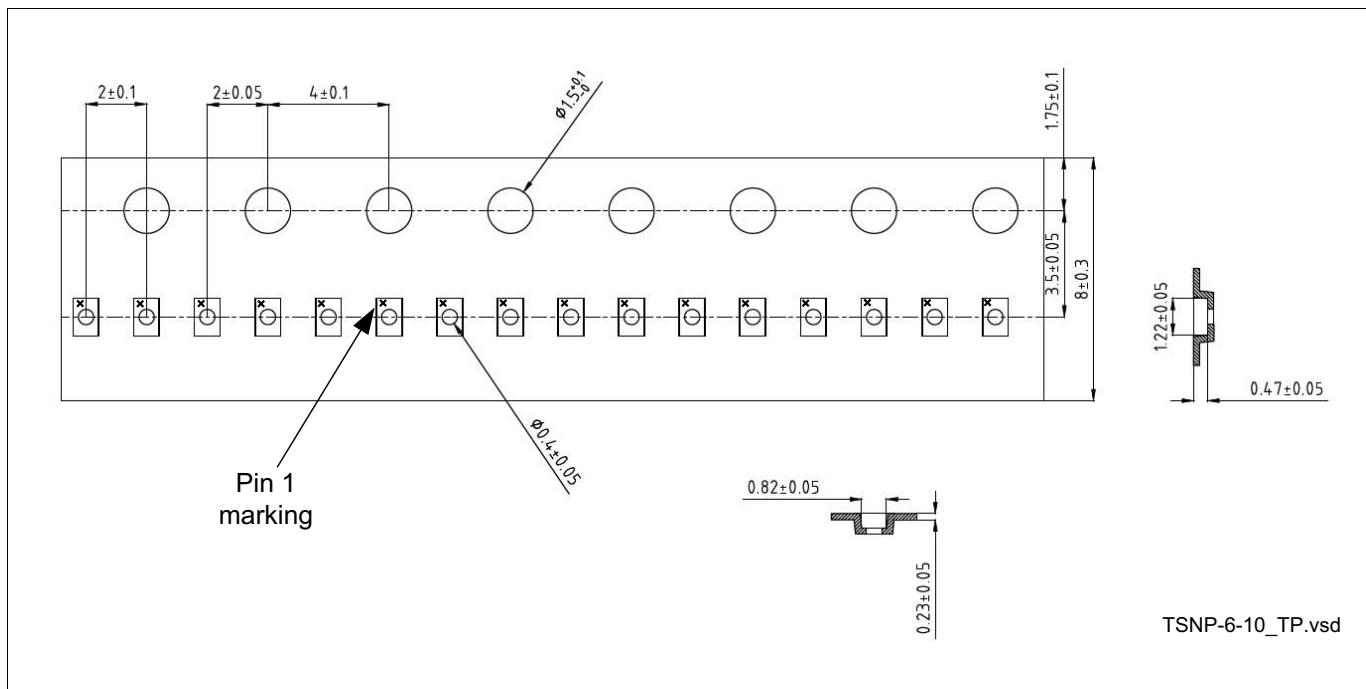


**Figure 13    Tape & Reel Dimensions TSNP-6-10 (reel diameter 180 mm, pieces/reel 12000)**

**Revision History**

| Page or Item | Subjects (major changes since previous revision) |
|---|---|
| **Revision 3.5, 2023-01-12** | |
| 6-9 | Update Power On Voltage in On-Mode |
| | |
| | |
| | |

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